CONSTRUCTION, GEOLOGIC, AND HYDROLOGIC DATA FOR OBSERVATION WELLS IN THE REELFOOT LAKE AREA, TENNESSEE AND KENTUCKY

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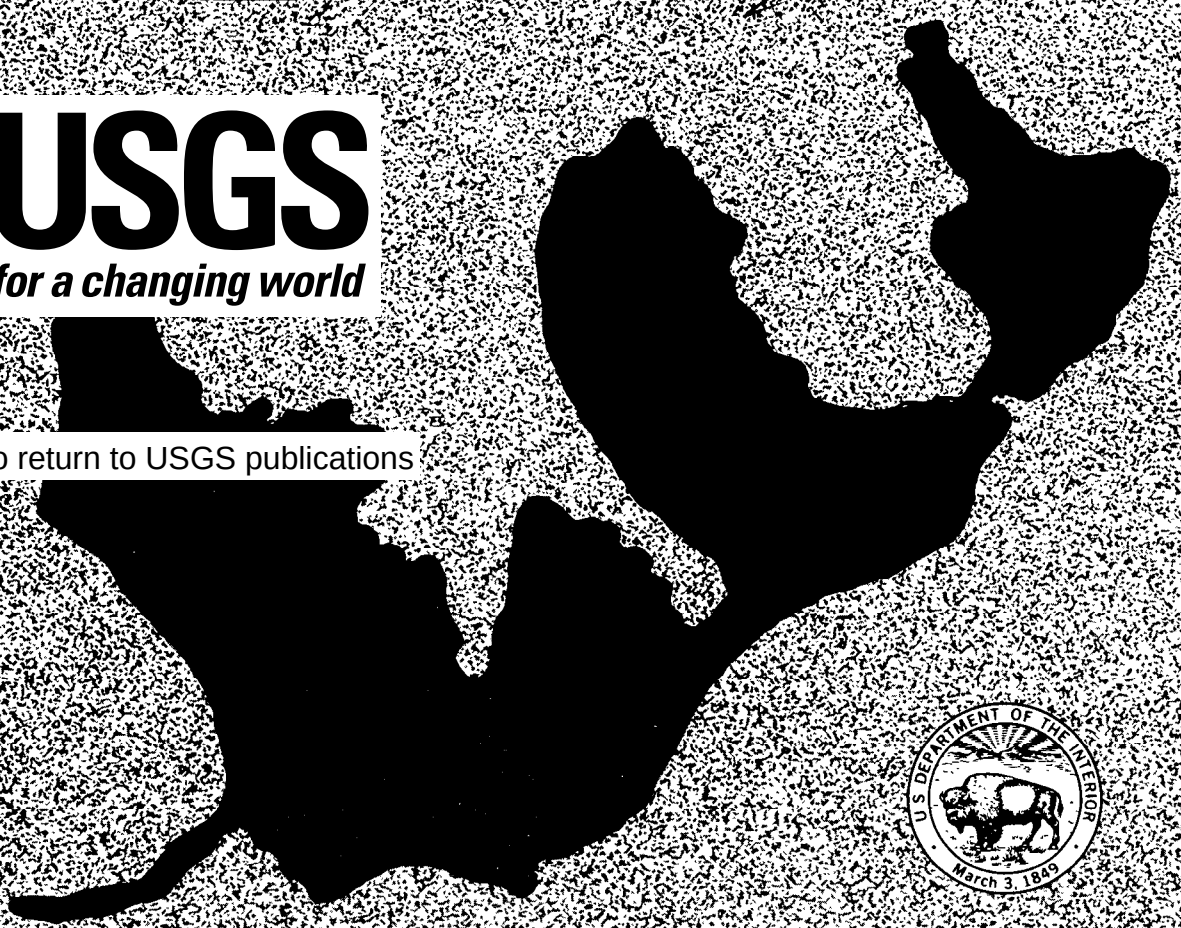

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CONSTRUCTION, GEOLOGIC, AND HYDROLOGIC DATA FOR OBSERVATION WELLS IN THE REELFOOT LAKE AREA, TENNESSEE AND KENTUCKY

Michael W. Bradley

U.S. GEOLOGICAL SURVEY

Open–File Report 87–249

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Nashville, Tennessee

1987

DEPARTMENT OF THE INTERIOR

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TABLES

CONVERSION FACTORS

Factors for converting inch-pound units to International System of Units (SI) are shown to four significant digits.

Multiply	*By*	*To obtain*
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]
microsiemens per centimeter at 25 °C (μS/cm)	1	micromoho per centimeter at 25 ° C (μho/cm)

CONSTRUCTION, GEOLOGIC, AND HYDROLOGIC DATA FOR OBSERVATION WELLS IN THE REELFOOT LAKE AREA, TENNESSEE AND KENTUCKY

By Michael W. Bradley

ABSTRACT

Twenty-three observation wells were installed at 12 sites in the Reelfoot Lake area of Tennessee and Kentucky during July 1986. The wells were installed to supplement the existing water-level network and to provide additional data on the hydraulic characteristics and vertical hydraulic gradients in the alluvial aquifer near Reelfoot Lake. Well yields ranged from less then 20 gallons per minute to about 140 gallons per minute. Specific capacity ranged from less than 1 to 17.1 gallons per minute per foot of drawdown.

Three stratigraphic sequences were encountered during drilling. Clay and silty clay was about 40 feet deep near the southwest corner of Reelfoot Lake. Predominantly medium- to coarse-grained sand ocurred below about 15 feet of silt and clay near the west and northwest sides of Reelfoot Lake. Along the western limit of the study area, near Lake No. 9 and the Mississippi River, about 20 to 30 feet of silt and silty sand occurred below land surface.

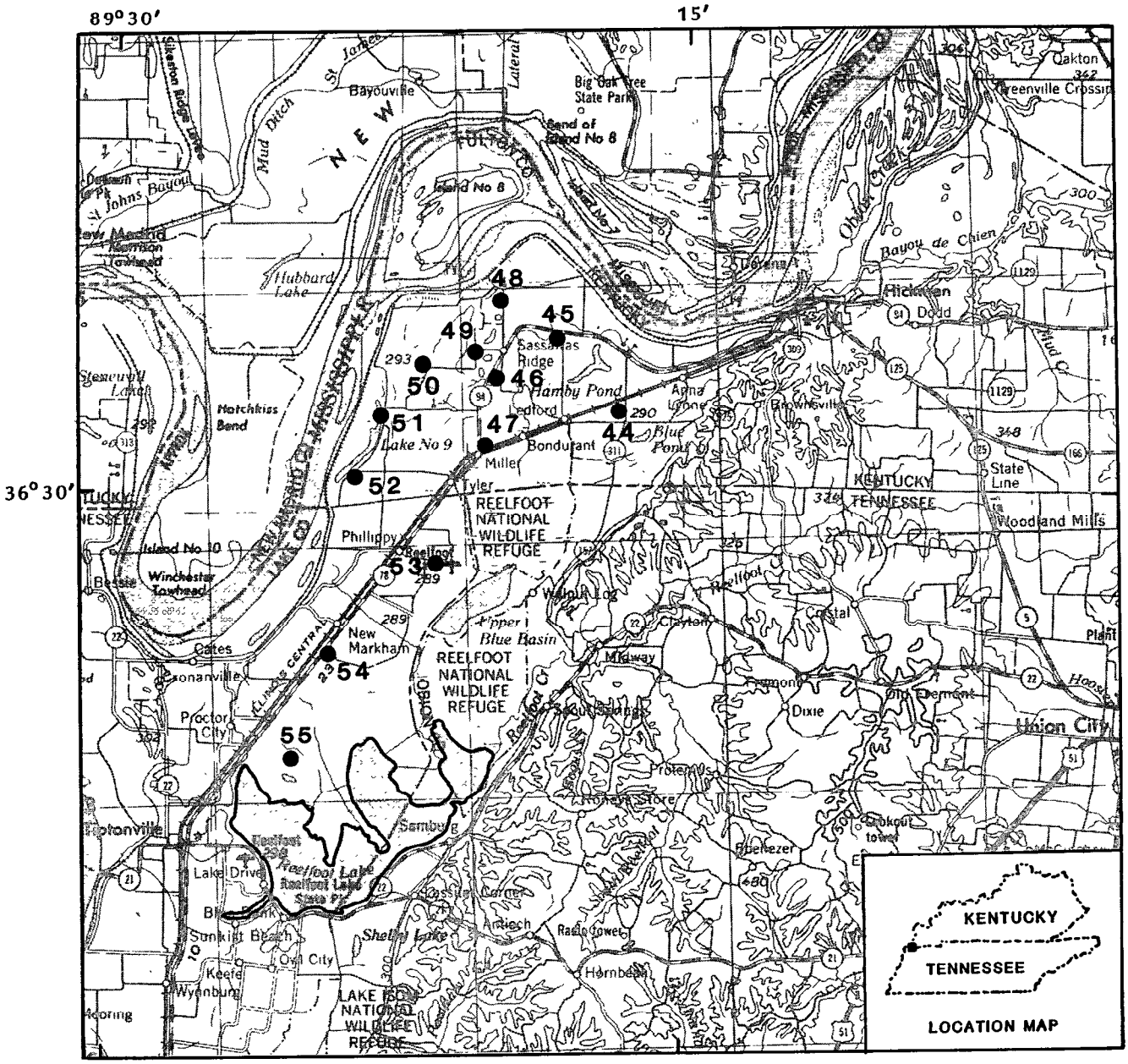
INTRODUCTION

Reelfoot Lake in extreme northwest Tennessee (fig. 1) was formed during the New Madrid earthquake of 1811-12. Since that time the lake has been an important natural resource to Tennessee and adjoining states. Recently, the U.S. Geological Survey, in cooperation with the Tennessee Wildlife Resources Agency, began an investigation of the surface- and ground-water interactions and their effects on the hydrologic system of Reelfoot Lake. The study included the installation of 23 wells at 12 sites in the Reelfoot Lake area of Tennessee and Kentucky (fig. 1). These wells were installed to supplement the original well network (Robbins and others, 1985) and to provide information on the vertical hydraulic gradient and the hydrologic characteristics of the shallow alluvial aquifer. The purpose of this report is to describe the construction of the wells, the lithology encountered, and the results of some short-term hydrologic tests conducted following well construction.

The Reelfoot Lake area of Fulton County, Kentucky, and Lake and Obion Counties, Tennessee, occurs in the alluvial valley of the Mississippi River. An escarpment formed by the loess uplands marks the eastern extent of the valley. The study area is underlain by unconsolidated loess, sand, silt, gravel, and clay. Formations present, in descending order are, loess, Mississippi River alluvium, Jackson Formation(?), and the Claiborne Group. The loess occurs only in the uplands east of Reelfoot Lake. In the valley, the alluvium occurs at land surface.

WELL CONSTRUCTION

Twenty-three wells were installed using a hollow-stem auger drilling rig. Casing and screen were generally installed through the augers. After drilling, the augers were withdrawn and the formation material allowed to collapse around the screen and casing. The remaining annulus was backfilled with cuttings and then grouted at land surface. All wells were constructed with PVC casing and a 0.020-inch slot screen. At each site, one 4-inch diameter well was installed approximately 30 to 35 feet below land surface. Two-inch diameter observation wells were also installed to approximately the same depth at three sites to be used during aquifer tests. At three of the sites, deeper wells were



Base from U.S. Geological Survey, 1:250,000, Dyersburg, Tenn., Ky., Mo., Ill., 1956, revised 1970

SCALE 1:250,000

0 5 MILES

0 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

EXPLANATION

46 ● OBSERVATION WELL SITE AND SITE NUMBER

Figure 1.--Location of observation well sites in the Reelfoot Lake area, Tennessee and Kentucky.

installed (60 and 100 feet below land surface) to provide information on vertical hydraulic gradients. Well-construction data are listed in table 1 and construction diagrams are included in Appendix A.

GEOLOGY

Geologic samples were collected at 5-foot intervals during well construction and were used to determine the lithology of the formations. A log of the samples was kept for each well and was compared with gamma logs made at each site. The lithologic and gamma log for each site is presented in Appendix A.

Three principal lithologies were encountered in different areas around Reelfoot Lake. Near the southwest corner of the lake, at well site 55, approximately 40 feet of tight, brown to brown-gray clay and silty clay occurred below land surface. The clay was underlain by at least 15 feet of sand and silty sand. In this area, deep, possibly clay-filled meanders of the Mississippi River have been mapped previously (Stearns, 1981).

Near the northwest corner of Reelfoot Lake, at well sites 44 through 48, 53, and 54, approximately 10 to 20 feet of surficial silt and clay was encountered. Medium- to coarse-grained sand and some gravel occurred below the surficial sediments. The sand and gravel was up to 70 feet thick at well 46C. Well sites 49 through 52, near Pond

Table 1.--Well-construction data for observation wells in the Reelfoot Lake area

Well number		Latitude	Longitude	Altitude of land surface above NGVD of 1929, in feet [1]	Depth of well below land surface, in feet	Screened interval, in feet	Screen diameter, in inches	Date of construction
USGS	Project	° ' "	° ' "					
KY:F-1	44A	36 31 46	89 16 32	290	35.0	17.8 - 27.8	2	7-18-86
KY:F-2	44B	36 31 46	89 16 32	290	35.0	21.8 - 26.8	2	7-18-86
KY:F-3	44C	36 31 46	89 16 32	290	35.0	22.2 - 27.2	2	7-18-86
KY:F-4	45	36 33 37	89 18 07	296	30.0	17.6 - 27.6	4	7-18-86
KY:F-5	46A	36 32 43	89 20 01	292	45.0	24.5 - 29.5	4	7-22-86
KY:F-6	46B	36 32 43	89 20 01	292	60.0	55.0 - 60.0	2	7-22-86
KY:F-7	46C	36 32 43	89 20 01	292	100	87.5 - 92.5	2	7-22-86
KY:F-8	46D	36 32 43	89 20 01	292	35.0	23.7 - 28.7	2	7-22-86
KY:F-9	47	36 31 04	89 20 09	290	30.0	16.6 - 26.6	4	7-17-86
KY:F-10	48	36 34 11	89 19 42	294	45.0	16.6 - 26.6	4	7-19-86
KY:F-11	49	36 33 15	89 20 24	292	34.0	18.2 - 28.2	4	7-19-86
KY:F-12	50	36 32 50	89 21 42	290	40.0	18.3 - 28.3	4	7-19-86
KY:F-13	51A	36 31 54	89 22 46	290	50.0	24.0 - 29.0	4	7-21-86
KY:F-14	51B	36 31 54	89 22 46	290	100	87.4 - 92.4	2	7-21-86
KY:F-15	51C	36 31 54	89 22 46	290	95.0	10.6 - 20.6	4	7-21-86
KY:F-16	52A	36 30 38	89 22 41	292	40.0	17.3 - 27.3	4	7-21-86
KY:F-17	52B	36 30 38	89 22 41	292	40.0	32.0 - 37.0	2	7-21-86
KY:F-18	52C	36 30 38	89 22 41	292	40.0	20.8 - 25.8	2	7-21-86
LK:H-5	53A	36 28 42	89 21 17	286	45.0	16.9 - 26.9	4	7-17-86
LK:H-6	53B	36 28 42	89 21 17	286	65.0	54.0 - 59.0	2	7-23-86
LK:H-7	53C	36 28 42	89 21 17	286	100	90.0 - 95.0	2	7-23-86
LK:G-30	54	36 27 09	89 24 15	286	30.0	18.7 - 28.7	4	7-16-86
LK:H-31	55	36 24 44	89 25 07	288	60.0	38.6 - 48.6	4	7-16-86

[1] Altitude determined from topographic map.

Slough and Lake No. 9, were underlain by 20 to 30 feet of silt and silty clay. This was underlain by very-fine to fine sand interbedded with silt and silty sand. Fine- to coarse-grained sand occurred below this zone to about 100 feet below land surface at well site 51.

SPECIFIC-CAPACITY TESTS

The observation wells were pumped to determine yields and the specific capacity of the alluvial aquifer. Yields ranged from about 1 gallon per minute (gal/min) to about 140 gal/min (table 2). Specific capacities in the alluvial aquifer ranged from less than 1 gallon per minute per foot of drawdown (gal/min/ft) to 17.1 gal/min/ft at well 51B. All tests were conducted with a centrufigal pump or a 4-inch submersible pump, and discharge was monitored during the test.

WATER QUALITY

Water-quality samples were collected at six wells during February 1987. The samples were analyzed for

Table 2.--Specific-capacity data for observation wells in the Reelfoot Lake area

Well number USGS	Project	Screened interval, in feet	Pumping rate, in gallons per minute	Static water level below measuring point, in feet	Pumping water level, in feet	Drawdown, in feet	Specific capacity, in gallons per minute per foot	Pumping period, in hours	Date of test
KY:F-1	44A	17.8 - 27.8	100	5.70	15.0	9.30	11	4	2-25-87
KY:F-5	46A	24.5 - 29.5	20	3.40	10.4	7.00	2.9	.75	7-22-86
			22	5.00	14.8	9.80	2.6	1.0	2-26-87
KY:F-6	46B	55.0 - 60.0	22	3.65	9.73	6.08	3.6	.50	7-22-86
KY:F-7	46C	87.5 - 92.5	20	3.80	13.2	9.40	2.1	.50	7-22-86
KY:F-9	47	16.6 - 26.6	5	7.20	20.0	12.8	<1	.50	2-24-87
KY:F-10	48	16.6 - 26.6	78	7.55	18.9	11.4	6.9	.50	7-19-86
KY:F-11	49	18.2 - 28.2	85	6.70	19.1	12.4	6.9	.50	7-19-86
			75	9.60	19.9	10.3	7.3	.33	2-24-87
KY:F-12	50	18.3 - 28.3	1.2	8.30	18.5	10.2	<1	.42	2-24-87
KY:F-14	51B	87.4 - 92.4	24	9.50	10.9	1.40	17.1	.50	7-21-86
KY:F-16	52A	17.3 - 27.3	1	9.00	18.6	9.60	<1	.33	2-25-87
LK:H-5	53A	16.9 - 26.9	140	3.62	16.3	12.7	8.2	.50	7-17-86
			89	6.40	19.1	12.7	7.0	.45	2-26-87
LK:H-6	53B	54.0 - 59.0	25	5.40	10.6	5.20	4.8	.50	7-23-86
LK:H-7	53C	90.0 - 95.0	20	5.50	9.90	4.40	4.6	.50	7-23-86
LK:G-30	54	18.7 - 28.7	85	4.06	20.26	16.2	5.3	.75	2-25-87

major constituents, trace metals, and nutrients (table 3). Wells 44A, 46A, 53A, and 54 are completed in the upper 30 feet of the alluvial aquifer and provide representative samples for that interval. Samples from wells 53B and 53C along with the sample from well 53A were collected to provide information on vertical changes in water quality within the alluvium.

Specific conductance in the upper 30 feet of the alluvium ranged from 225 microsiemens per centimeter at well 44A to 750 microsiemens per centimeter at well 54. Dissolved nitrite and nitrate was highest, 4.4 milligrams per liter as nitrogen, at well 44A. Water-quality samples at site 54 showed little variation in water quality with depth. Specific conductance was 430, 430, and 425 microsiemens per centimeter at wells 53A, 53B, and 53C, respectively (table 3).

Table 3.--Water-quality data for the Reelfoot Lake area

	Well number					
	KY:F-1 44A	KY:F-5 46A	LK:G-30 54	LK:H-6 53B	LK:H-7 53C	LK:H-5 53A
Date	2-25-87	2-24-87	2-25-87	2-26-87	2-26-87	2-26-87
Elevation of land surface datum (feet above NGVD of 1929)	292	292	286	286	286	286
Depth of well, total (feet)	27.80	29.50	28.70	59.00	95.00	26.90
Temperature (°C)	16.5	17.0	17.5	16.0	16.0	16.0
Specific conductance (µS/cm)	225	605	750	430	425	430
pH (standard units)	6.10	6.30	6.60	6.70	6.70	6.60
Alkalinity, total field (mg/L as $CaCO_3$)	72	380	480	240	247	222
Nitrogen, ammonia dissolved mg/L as N)	.06	3.40	.80	--	.21	.11
Nitrogen, ammonia, total (mg/L as N)	.05	3.50	.80	--	.20	.11
Nitrogen, nitrite, dissolved (mg/L as N)	.02	<.01	<.01	--	<.01	<.01
Nitrogen, ammonia & organic total (mg/L as N)	.9	3.7	1.6	--	.3	.8
Nitrogen, NO2 + NO3 dissolved (mg/L as N)	4.40	<.10	<.10	--	<.10	<.10
Phosphorus, total (mg/L as P)	.19	.07	.06	--	.96	.27
Phosphorus, dissolved (mg/L as P)	.17	.17	.05	--	.16	.27
Phosphorus, ortho, dissolved (mg/L as P)	.18	<.01	.05	--	.04	.27
Calcium, dissolved (mg/L as Ca)	25	86	120	--	59	57
Magnesium, dissolved (mg/L as Mg)	6.2	18	35	--	19	18
Manganese, dissolved (µg/L as Mn)	120	1	4,700	--	<1	3
Sodium, dissolved (mg/L as Na)	7.9	6.8	6.7	--	6.0	6.4
Potassium, dissolved (mg/L as K)	1.0	2.2	2.4	--	1.9	2.8
Chloride, dissolved (mg/L as Cl)	3.4	5.6	4.5	--	1.7	2.0
Sulfate, dissolved (mg/L as SO_4)	23	1.8	1.2	--	11	7.2
Fluoride, dissolved (mg/L as F)	.2	.4	.3	--	.3	.5
Silica, dissolved (mg/L as SiO_2)	30	37	30	--	37	26
Iron, dissolved (µg/L as Fe)	7	17,000	14	--	6	4
Solids, residue at 180 °C, dissolved (mg/L)	153	326	475	--	260	247

REFERENCES

Robbins, C.H., Garrett, J.W., and Mulderink, D.M., 1985, May 1984–April 1985 Water budget of Reelfoot Lake with estimates of sediment inflow and concentrations of pesticides in bottom material in tributary streams – Basic data report: U.S. Geological Survey Open-File Report 85-498, 37 p.

Stearns, R.G., 1981, Influence of shallow structure, and a clay-filled Mississippi River channel on details of the gravity field at the Reelfoot Scarp, Lake County, Tennessee: U.S. Nuclear Regulatory Commission, NUREG/CR-2130, 61 p.

APPENDIX A

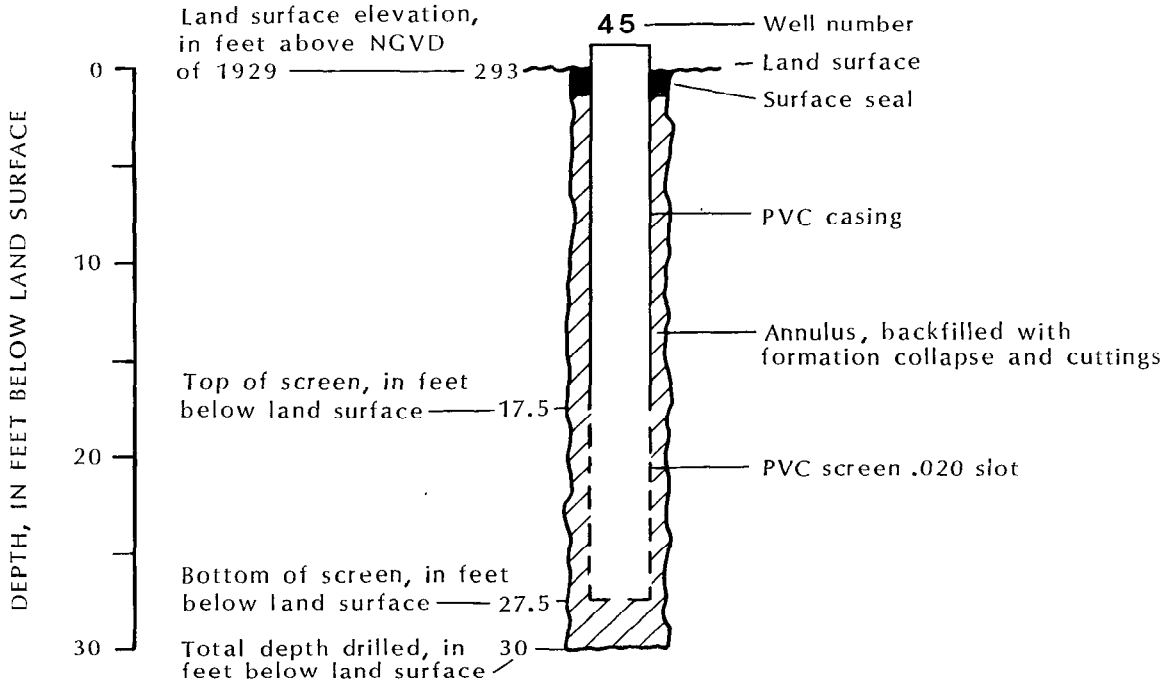
Well-construction diagrams and lithology

APPENDIX A

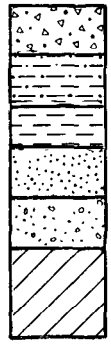
Well-construction diagrams and lithology

EXPLANATION

WELL-CONSTRUCTION DIAGRAMS



LITHOLOGY



Road fill; gravel, silt, and sand

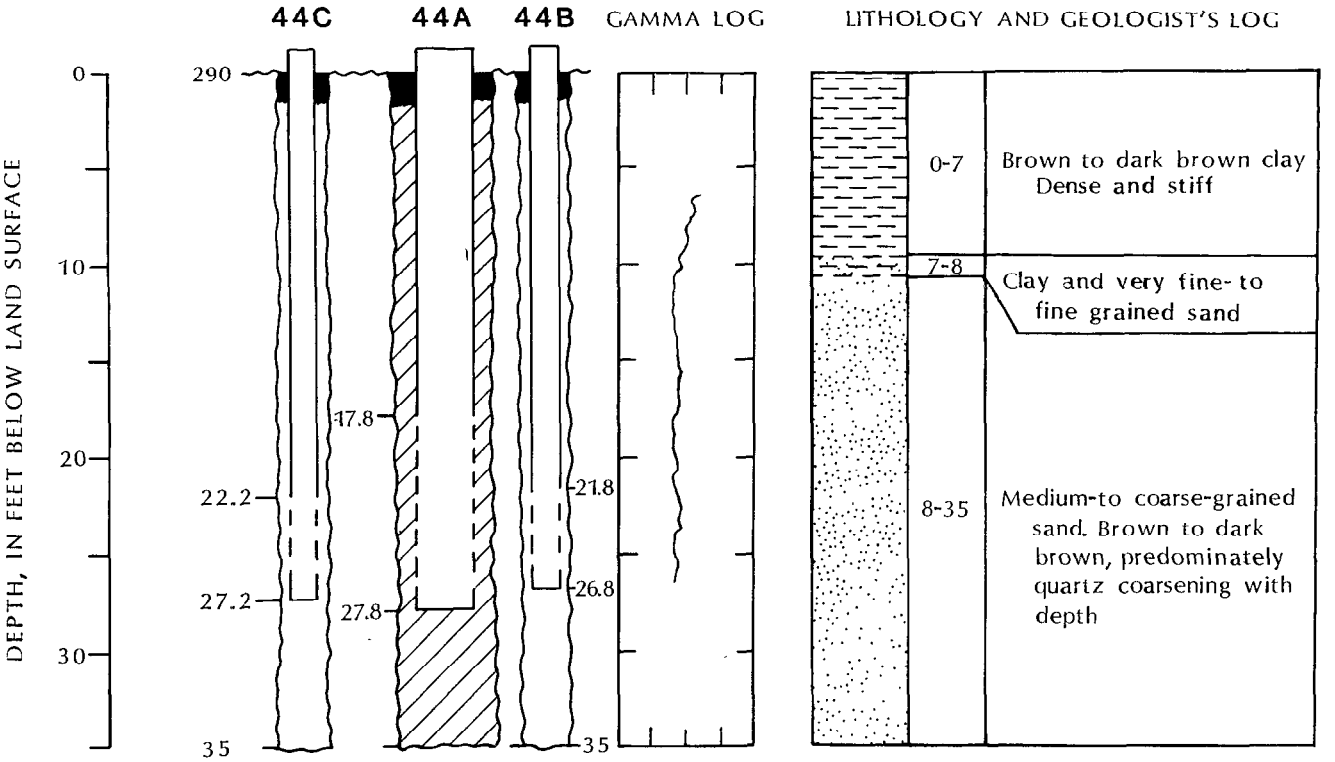
Silt

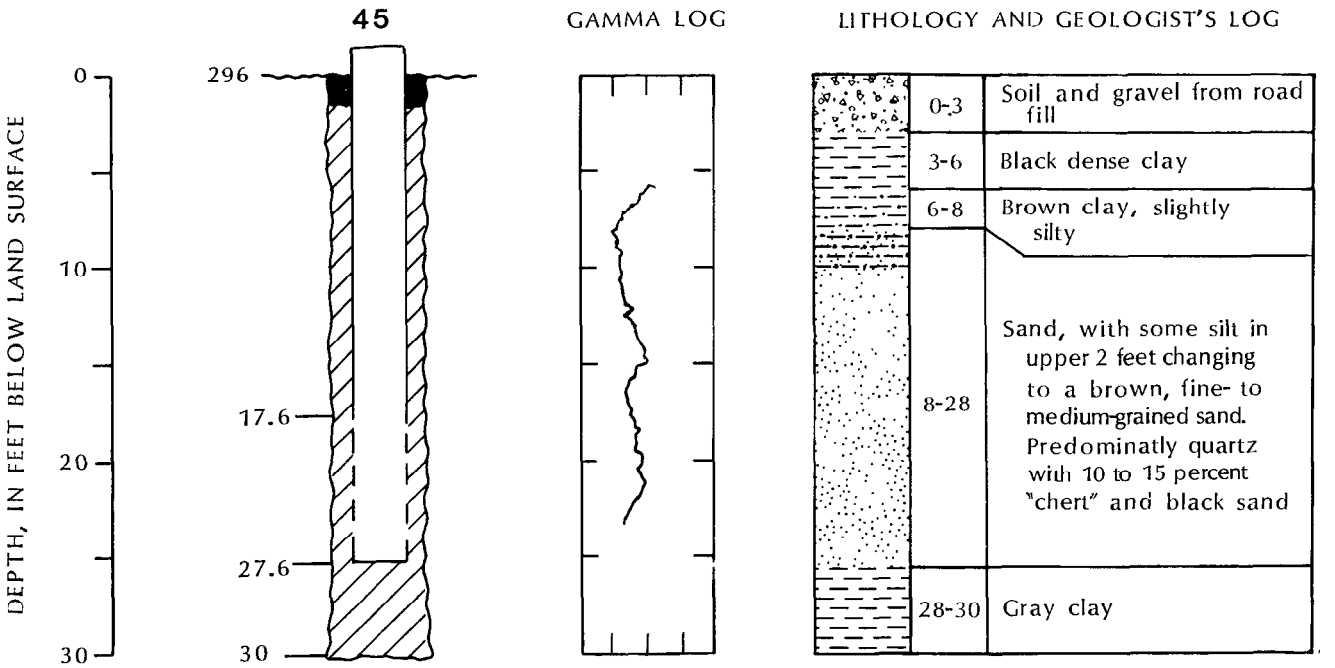
Clay

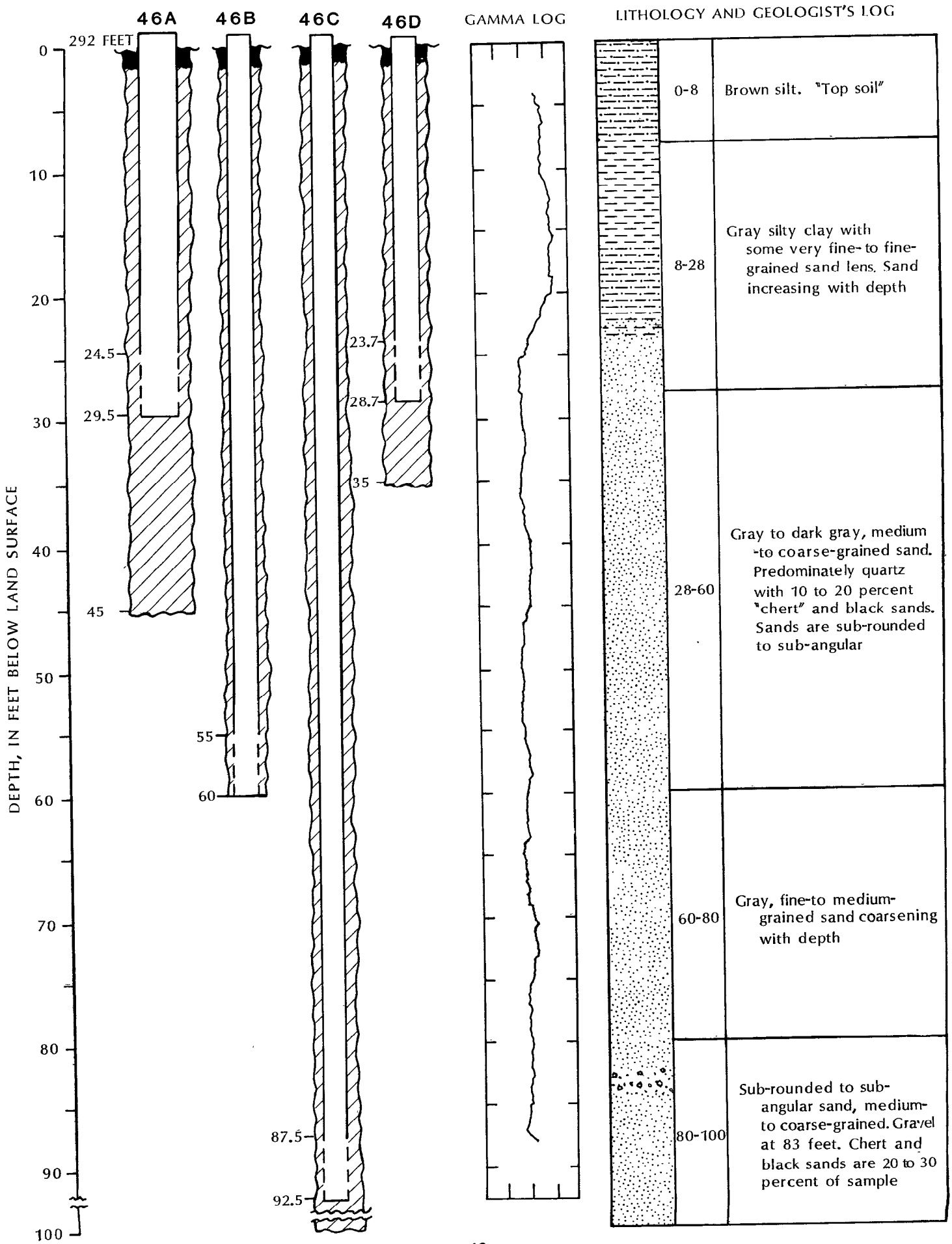
Sand

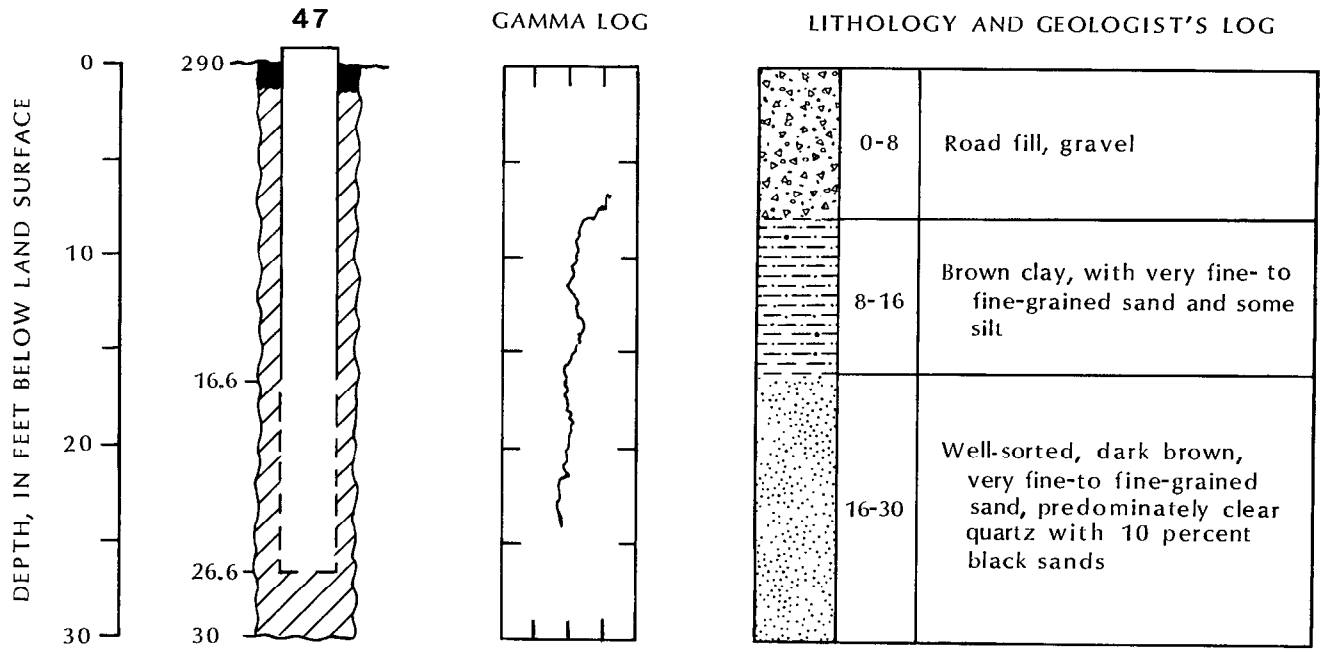
Gravel

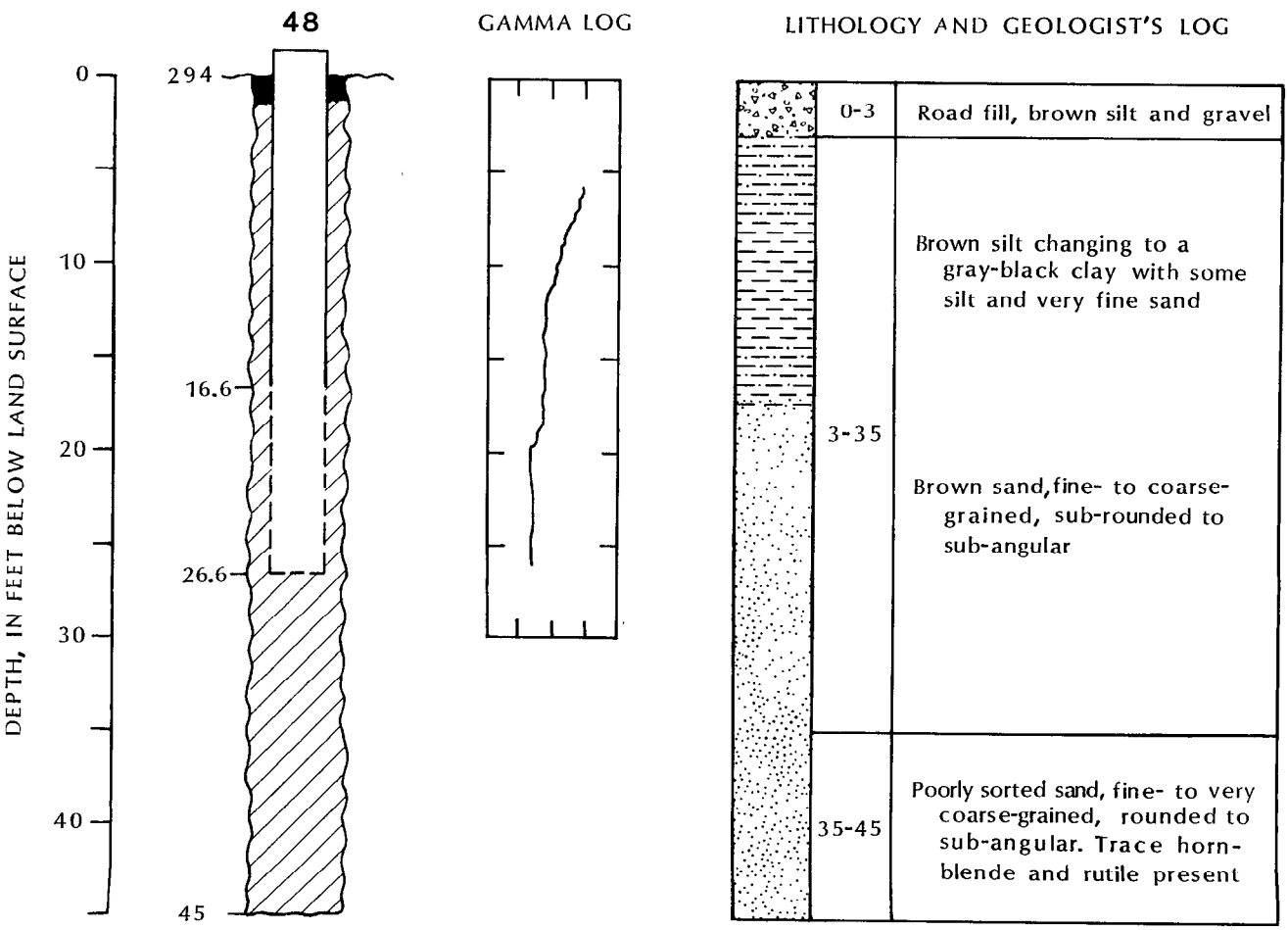
No returns


44C
44A
44B
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
290
17.8
22.2
27.2
27.8
21.8
26.8
35
35
0-7
Brown to dark brown clay Dense and stiff
7-8
Clay and very fine- to fine grained sand
8-35
Medium-to coarse-grained sand. Brown to dark brown, predominately quartz coarsening with depth


45
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
296
17.6
27.6
30
0-3
Soil and gravel from road fill
3-6
Black dense clay
6-8
Brown clay, slightly silty
8-28
Sand, with some silt in upper 2 feet changing to a brown, fine- to medium-grained sand. Predominatly quartz with 10 to 15 percent "chert" and black sand
28-30
Gray clay


46A
46B
46C
46D
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
292 FEET
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
80
90
100
24.5
29.5
45
55
60
23.7
28.7
35
87.5
92.5
0-8
Brown silt. "Top soil"
8-28
Gray silty clay with some very fine- to fine-grained sand lens. Sand increasing with depth
28-60
Gray to dark gray, medium -to coarse-grained sand. Predominately quartz with 10 to 20 percent "chert" and black sands. Sands are sub-rounded to sub-angular
60-80
Gray, fine-to medium-grained sand coarsening with depth
80-100
Sub-rounded to sub-angular sand, medium- to coarse-grained. Gravel at 83 feet. Chert and black sands are 20 to 30 percent of sample

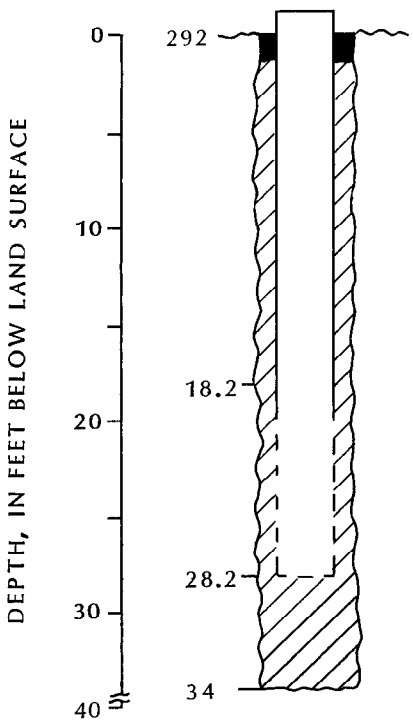

47
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
290
16.6
26.6
30
0-8
Road fill, gravel
8-16
Brown clay, with very fine- to fine-grained sand and some silt
16-30
Well-sorted, dark brown, very fine-to fine-grained sand, predominately clear quartz with 10 percent black sands

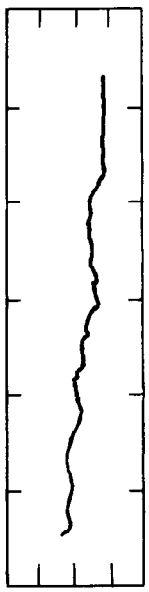

48
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
294
16.6
26.6
45
0-3
Road fill, brown silt and gravel
3-35
Brown silt changing to a gray-black clay with some silt and very fine sand
Brown sand, fine- to coarse-grained, sub-rounded to sub-angular
35-45
Poorly sorted sand, fine- to very coarse-grained, rounded to sub-angular. Trace hornblende and rutile present

49

GAMMA LOG

LITHOLOGY AND GEOLOGIST'S LOG





0-3	Road fill
3-13	Brown silt with some clay, some very fine-grained sand
13-25	Brown, fine-grained sand, contains abundant silt
25-34	Brown, fine- to medium-grained sand, round to sub-rounded becoming coarser with depth

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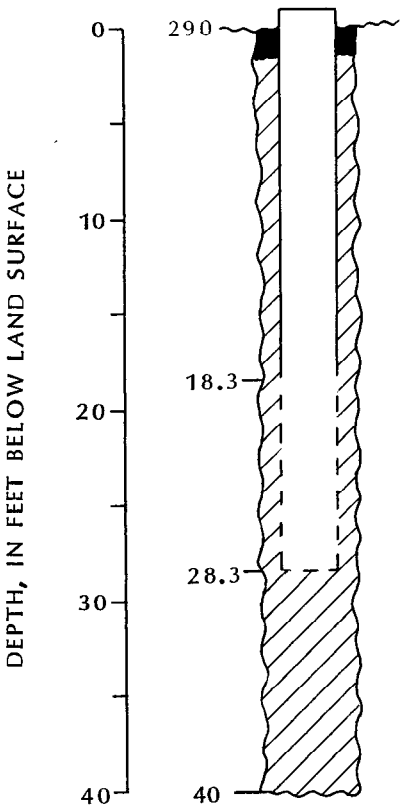
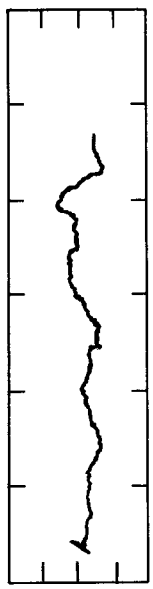
50

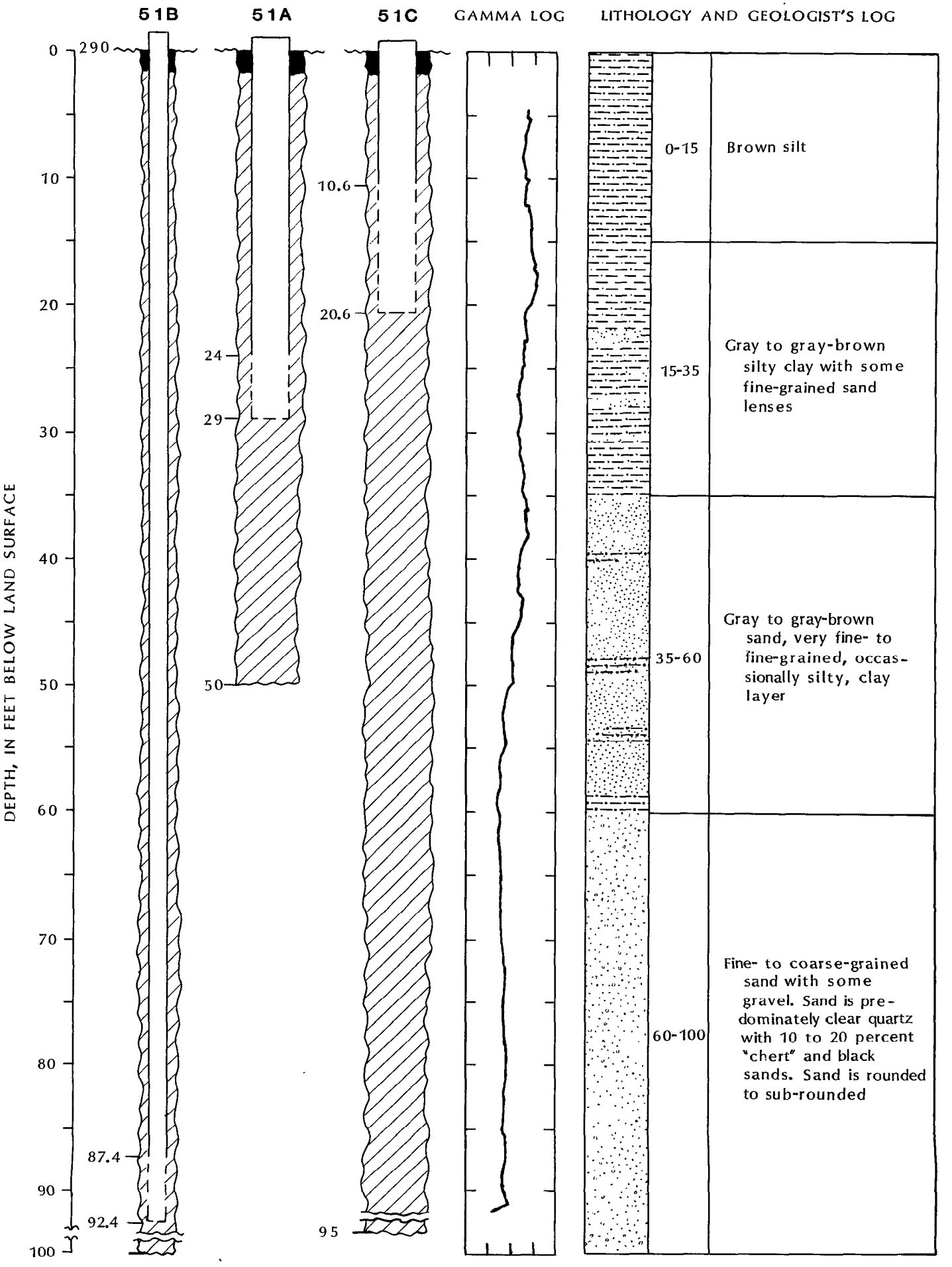
GAMMA LOG

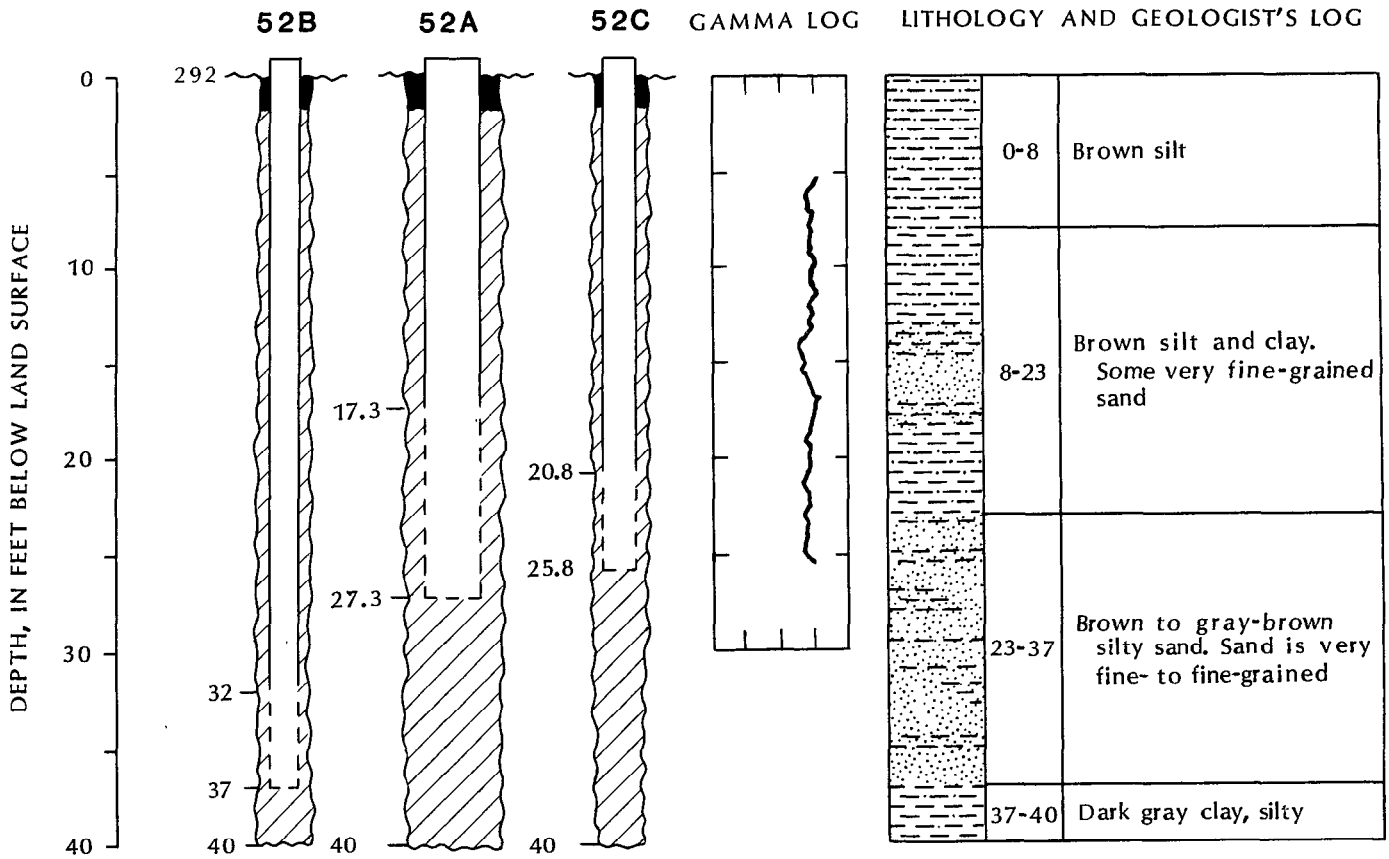
LITHOLOGY AND GEOLOGIST'S LOG

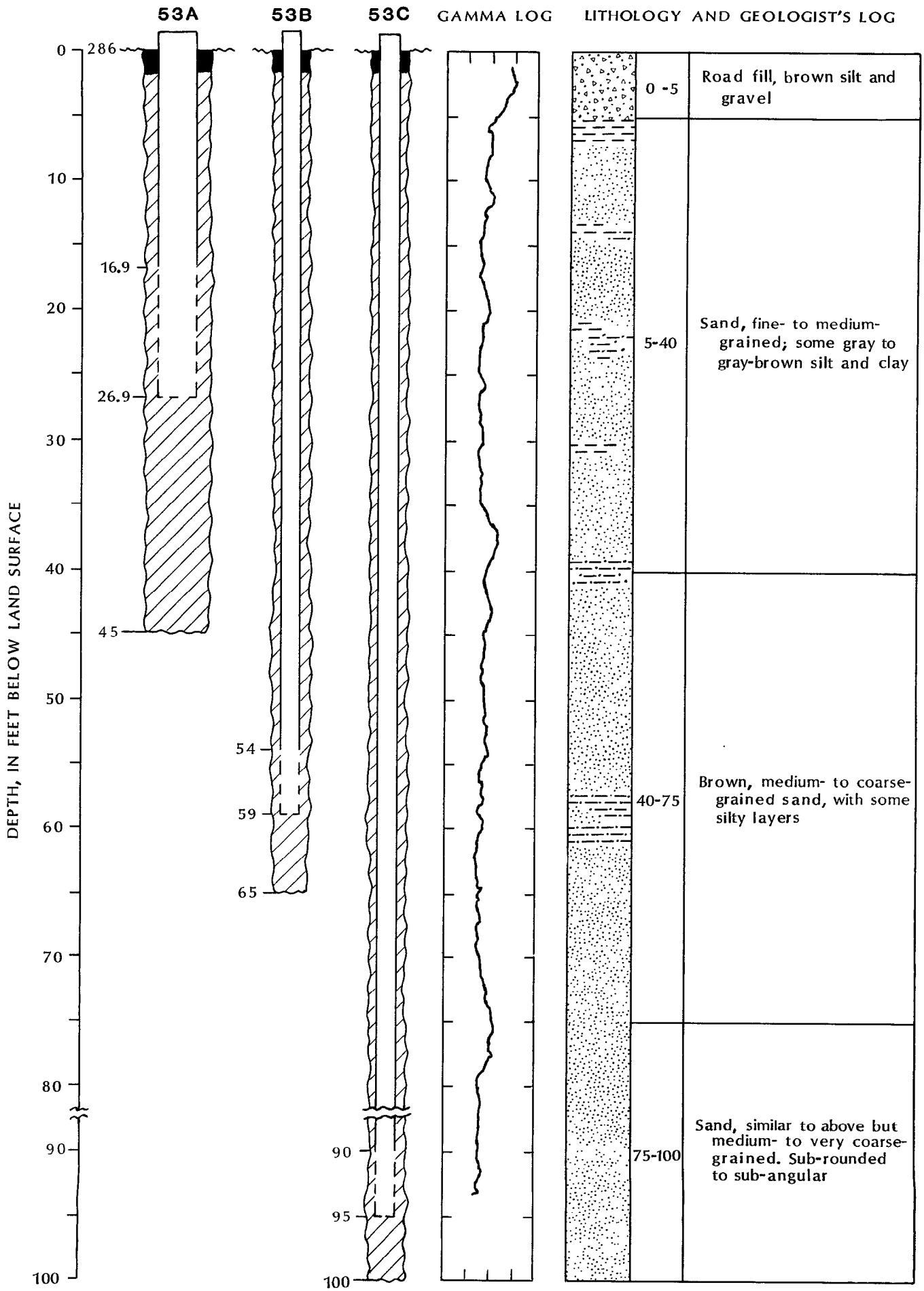


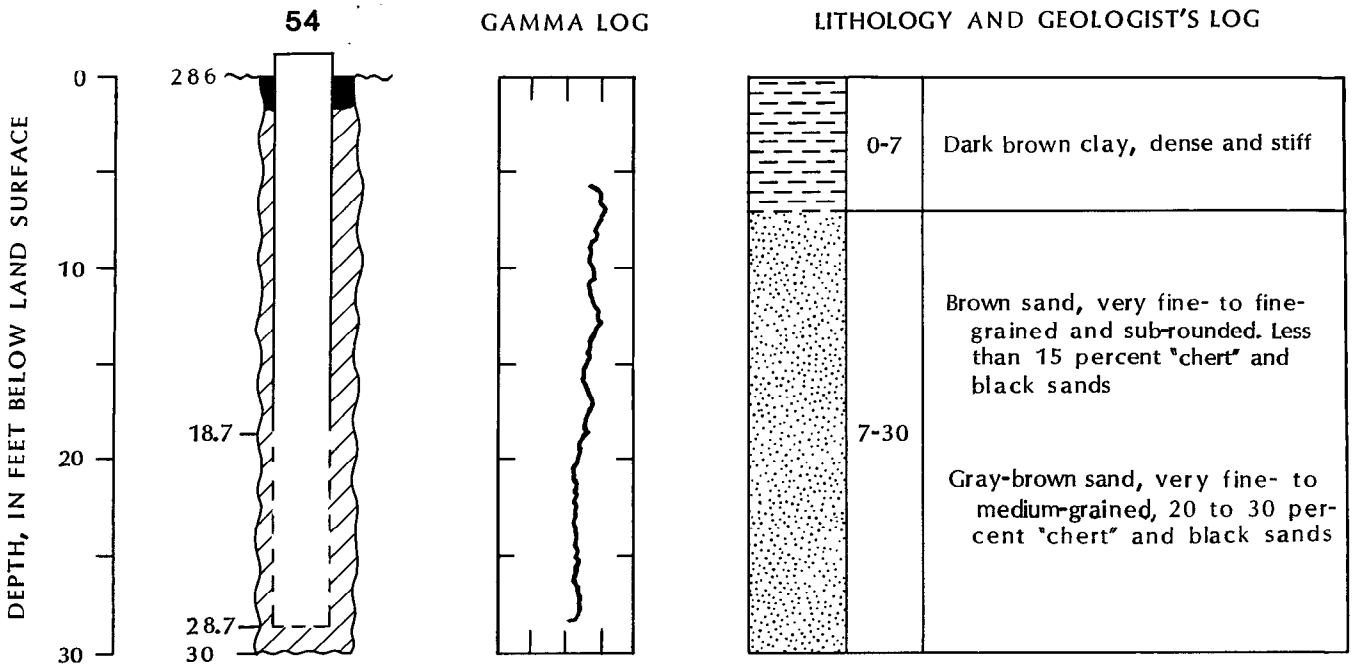


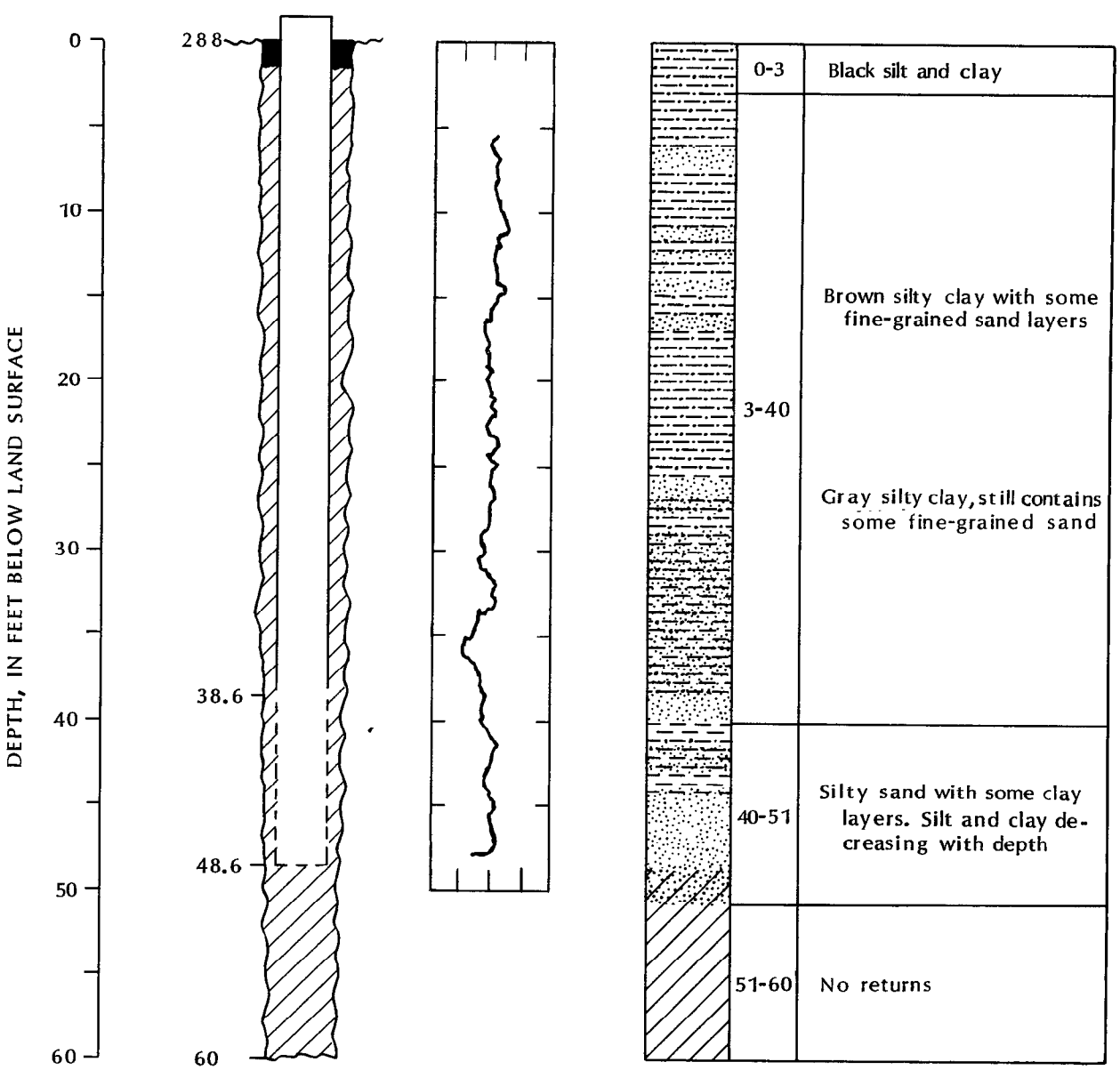
0-3	Road fill
3-12	Gray-black to brown clay, increasing silt content with depth
12-30	Sand and silt in clay matrix, some fine-grained sand in lenses. Sand increasing with depth
30-40	Gray-brown silty sand. Sand is very fine- to fine-grained, some clay present


51B
51A
51C
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
80
90
100
290
10.6
20.6
24
29
50
87.4
92.4
95
0-15
Brown silt
15-35
Gray to gray-brown silty clay with some fine-grained sand lenses
35-60
Gray to gray-brown sand, very fine- to fine-grained, occasionally silty, clay layer
60-100
Fine- to coarse-grained sand with some gravel. Sand is predominately clear quartz with 10 to 20 percent "chert" and black sands. Sand is rounded to sub-rounded


52B
52A
52C
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
292
17.3
27.3
32
37
40
40
20.8
25.8
40
0-8
Brown silt
8-23
Brown silt and clay. Some very fine-grained sand
23-37
Brown to gray-brown silty sand. Sand is very fine- to fine-grained
37-40
Dark gray clay, silty


53A
53B
53C
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
80
90
100
286
16.9
26.9
45
54
59
65
90
95
100
0 -5
Road fill, brown silt and gravel
5-40
Sand, fine- to medium-grained; some gray to gray-brown silt and clay
40-75
Brown, medium- to coarse-grained sand, with some silty layers
75-100
Sand, similar to above but medium- to very coarse-grained. Sub-rounded to sub-angular


54
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
286
18.7
28.7
30
0-7
Dark brown clay, dense and stiff
7-30
Brown sand, very fine- to fine-grained and sub-rounded. Less than 15 percent "chert" and black sands
Gray-brown sand, very fine- to medium-grained, 20 to 30 percent "chert" and black sands


55
GAMMA LOG
LITHOLOGY AND GEOLOGIST'S LOG
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
288
38.6
48.6
60
0-3
Black silt and clay
3-40
Brown silty clay with some fine-grained sand layers
Gray silty clay, still contains some fine-grained sand
40-51
Silty sand with some clay layers. Silt and clay decreasing with depth
51-60
No returns

CONSTRUCTION GEOLOGIC AND HYDROLOGIC DATA FOR OBSERVATION WELLS IN THE KELLY OFR 81-249
LAKE AREA, TENNESSEE AND KENTUCKY